62-1-3

NUCOR

751 200

RESEARCH CHEMICALS

division of nuclear corporation of america

Sc														
Y														
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

Burbank, California

RC 173

RESEARCH CHEMICALS
division of Nuclear Corporation of America
Burbank, California

Released to ASTIA by the NAVAL WEAPONS
Bureau of
without restriction.

RARE EARTH INTERMETALLICS

Second Bi-monthly Report
for the period
January 15 to March 15, 1961

DEPARTMENT OF THE NAVY
Bureau of Naval Weapons
Washington 25, D.C.

Contract NOw 61-0257-c
Control 0266-61

INTRODUCTION

The first progress report (1) on this program summarized some criteria for evaluation of a series of high temperature intermetallics being studied. These included the first screening parameters:

(a) high melting point

(b) oxidation resistance at elevated temperatures

Several systems in which silicon was added progressively to both dysprosium and to hafnium have been examined cursorily. Additional progress is reported in this report on other intermetallics of both of the above elements.

EXPERIMENTAL

Several additional series of intermetallic compositions have been prepared by the arc-melting procedures previously reported (1). These included compositions in the hafnium-rhenium, hafnium-boron and hafnium-dysprosium systems. All ingots were examined for homogeneity prior to subsequent operations. Chemical analyses have been run on all preparations by methods developed for each particular binary system. (Details on these methods will be included as part of the final report). Initial and actual compositions are tabulated in Tables I, II, and III.

Preparation of a series of intermetallics in the dysprosium-rhenium system was also attempted. However, all samples showed such severe segregation that no additional work in this system was undertaken.

Oxidation resistance was measured by the atmospheric corrosion method previously described. All results are reported as weight gains per unit area (of surface exposed). The preliminary determinations reported here were made at 1000°C in a steady stream of pre-dried, heated air. The data are noted graphically in Figure 1 and in Table IV.

TABLE I

Hafnium-Boron Intermetallics

Nominal Compositions	% Boron (Nominal)	% Boron* (Actual)
HfB	6.5	4.1
HfB_2	13.	11.4
HfB_4	27.	17.3

* Some segregation was noted.

TABLE II

Hafnium-Rhenium Intermetallics*

Nominal Compositions	% Rhenium (Nominal)	% Rhenium (Actual)
Hf_9Re	10	6.3
Hf_2Re	30	27.0
HfRe	50	49.6

A hafnium dirhenide has been reported by Krikorian, et al (2) existing in a hexagonal Laves structure and with a melting point of 2935°C.

TABLE III

Hafnium-Dysprosium Intermetallics

Nominal Compositions	% Dysprosium (Nominal)	% Dysprosium (Actual)
Hf_3Dy	25	23.8
$HfDy$	50	44.7
$HfDy_3$	75	74.0

TABLE IV

CORROSION RATES IN HAFNIUM SYSTEMS AT 1000°C

Total Corrosion in g/dm^2

Sample	1/2 Hr.	1 Hr.	2 Hrs.	4 Hrs.	8 Hrs.
Hf-100%	0.105	0.144	0.241	0.345	1.133
Hf- 6.5% Re	0.117	0.160	0.304	0.601	--
Hf-17.3% B	0.135	0.163	0.197	0.225	0.308
Hf-11.4% B	0.059	0.085	0.118	0.146	0.192
Hf- 4.1% B	0.069	0.120	0.199	0.275	0.372
Hf-74.0% Dy	2.816	3.989	5.862	11.474	20.10
Hf-44.7% Dy	1.603	2.349	3.488	5.820	9.920
Hf-23.8% Dy	0.713	1.158	1.704	2.494	3.726

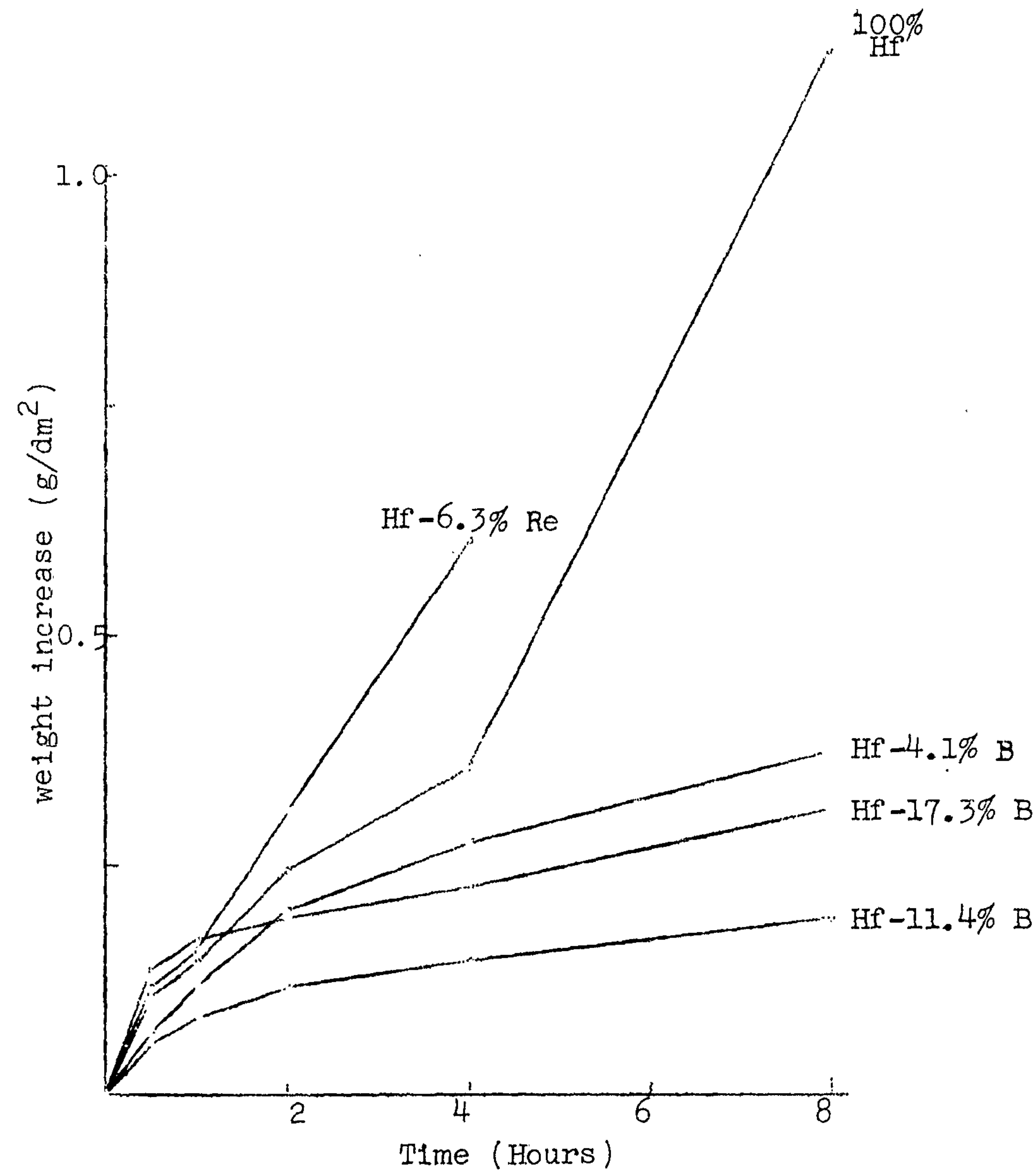

Figure 1. Corrosion Rates for Hf containing intermetallics

DISCUSSION

Intermetallics in the hafnium-rhenium system all had apparent corrosion rates greater than that for pure hafnium. Weight increases for the 6 percent composition are indicated in Figure 1. However, it was noted that there was volatilization from this sample during the course of the experiment. Alloys containing more than 10 percent rhenium all lost weight at the 1000°C test temperature.

Corrosion rate data in the hafnium-dysprosium system have been presented only in tabular form. However, it is evident that corrosion rates are all greater than that for pure hafnium, and further, that the rate is apparently proportional to the dysprosium content.

The data in the hafnium-boron system are of considerable interest. Although arc melting procedures did not produce intermetallics of the desired boron content, nevertheless the results indicate a considerable decrease in corrosion rates due to the formation of a hafnium boride. Additional efforts are planned in this area.

Some very preliminary experiments have been conducted with intermetallics of the rare earths with phosphorus. A preliminary check in the yttrium phosphorus system shows considerable improvement in corrosion resistance. This work is continuing and will be reported in greater detail in the next bi-monthly.

Program for the ensuing period. The program for the forthcoming period includes continued preparation of intermetallic compositions. Particular attention is to be focused on the hafnium-boron and yttrium-phosphorus systems.

REFERENCES

(1) Research Chemicals; Rare Earth Intermetallics, RC 167, First Bi-Monthly Report. Research Chemicals Division of Nuclear Corporation of America, Burbank California (December 1960)

(2) N. H. Krikorian, et al; The Preparation, Crystal Structures and Some Properties of Zirconium and Hafnium Dirheride, J. of Phy. Chem, 64, 1517 (1960.